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AUTHOR Slate, John R.; Charlesworth, John R., Jr.
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ABSTRACT

The information processing model, a theoretical framework of how humans think, reason, and learn, views human cognitive functioning as analogous to the operation of a computer. This paper uses the increased understanding of the information processing model to provide teachers with suggestions for improving the teaching-learning process. Major theoretical concepts in cognitive psychology are explained and specific ways to utilize each concept are delineated. These concepts are (1) attention; (2) active learning; (3) meaningfulness; (4) organization; (5) advance organizers; (6) memory aids; (7) overlearning; and (8) automaticity. A number of suggestions are provided as to how teachers can incorporate more of the new knowledge gained from the information processing theory into their classrooms. In addition, the model provides a strong theoretical rationale supporting many traditional teaching techniques. (JD)

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Information Processing Theory: Classroom Applications

John R. Slate

Arkansas State University

and

John R. Charlesworth, Jr.

Western Carolina University

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ABSTRACT

The information processing model, a theoretical framework of how humans learn and remember, has been developed enough to provide teachers with suggestions for improving the teaching-learning process. Major theoretical concepts in cognitive psychology are explained and specific ways to utilize each concept are delineated.

Information Processing Theory: Classroom Applications

During the past decade, cognitive psychologists have obtained an increased understanding of how humans think, reason, and learn. Much of this gain can be attributed to the continuing development of a theoretical framework known as the information processing model of human memory (Anderson, 1985; Atkinson & Shiffrin, 1968; Craik & Lockhart, 1972; Gagne, 1985). This model, ascribed to by the majority of American psychologists, views human cognitive functioning as analogous to the operation of a computer. Our purpose in writing this paper is to utilize the increased understanding of the information processing model to provide teachers with suggestions for improving the teaching-learning process. Major theoretical concepts of attention, active learning, meaningfulness, organization, advance organizers, memory aids, overlearning, and automaticity are mentioned, briefly explained, and then applications of each concept are specified.

Attention

Information that is not attended to does not enter into the information processing system (Gagne, 1985). Without a student's attention to the task at hand, learning cannot occur.

Thus, attention is a necessary precursor for learning. In order to focus student attention on the learning tasks, both effective motivational and classroom management skills are necessary (Klausmeier, 1985). That is, educators need to create a set of techniques to attract and hold students' attention (Biehler & Snowman, 1986). The following procedures are recommended for increasing students' attention: (a) Use, but don't overuse, novelty when presenting material. A novel procedure becomes routine if used continually. (b) Move around the room, use gestures, and avoid speaking in a monotone. (c) Help students focus on the most important information through voice inflection, pauses, writing on the board, or reviewing. (d) Cue students to material they will be asked to reproduce later by asking them to summarize the important points in a presentation. (e) Ask students questions in a random manner. This enhances the probability that all students will be attentive. (f) When possible, eliminate any unnecessary distractions caused by lighting, noise, temperature, uncomfortable chairs, etc. (g) Make sure you have the students' attention prior to presenting information.

Active Learning

Research has demonstrated clearly that students learn best when they are actively involved in the learning process (Glover, Bruning, & Filbeck, 1983). The value that the information processing model places upon a learner being an active rather than a passive participant in the learning process is exemplified by the humorous paraphrasing of an old adage by Rothkopf (1970, p. 325), "You can lead a horse to water but the only water that gets into his stomach is what he drinks." (a) To encourage active participation by students, teachers should talk less, and spend more time using discussion, group activities, and individual activities and exercises in the classroom setting. (b) More activity by itself is inadequate to enhance learning. Cognitive effort must be expended for the class activity to be beneficial. Thus, students can be active during lecture and passive in discussion. Teachers who ask questions that require students to go beyond rote recall of facts are more likely to generate active discussion (i.e., more cognitive effort). (c) Another way to encourage the expenditure of cognitive energy is to grade assignments. Students may not invest mental effort in a task unless they know it will be

graded or has a good probability of being evaluated. An example would be asking exam questions over term paper topics to increase the cognitive effort on the paper. (d) When viewing films or videotapes, students tend not to be mentally active unless they are cued to important issues and they know they will be tested on the material.

Meaningfulness

Meaningfulness is one of the most important elements of the information processing model. Research has indicated that when material is made meaningful, it is learned more rapidly and retained for longer periods of time than rote learning (Biehler & Snowman, 1986; Brown, 1975; Glover, Bruning & Filbeck, 1983; Lefrancois, 1985; Lindgren & Suter, 1980; Meacham, 1972; White & Gagne, 1976). Meaningfulness occurs when students are able to grasp generalizations, rules, relationships between facts, and principles for which they see some use; when they are able to associate new information with their past knowledge and/or experiences; and, when information is presented at the learner's level of understanding.

Actions that classroom teachers can take to enhance meaningfulness are: (a) Show students how new information is related to other material they have already learned.

(b) Provide students with multiple examples for each new concept that illustrate both inclusive and exclusive characteristics. (c) Use outlines, diagrams, analogies, examples, and demonstrations to assist in making the relationships between new and old information clear. (d) Assist students in forming associations between new material and their existing knowledge or experiences. (e) Provide assignments that require students to integrate new knowledge with existing knowledge. (f) For appropriately mature students, have them generate their own examples that require the formation of new associations. (g) Meaningfulness can be increased by illustrating practical applications of material, especially applications relevant to students' lives. Teachers can also assess meaningfulness by asking questions that require students to generalize material to new situations. (h) Have students paraphrase or place information into their own words.

The common elements of these suggestions is that new material will be learned and retained better when learners are required to actively process information and develop meaningful associations than when they merely try to memorize it rotely. Learning of new material is facilitated when the learner has an

existing network of related ideas to which s/he can relate the new material (Klausmeier, 1985; Lindgren & Suter, 1980).

Organization

Closely related to meaningfulness is the concept of organization. Information that is presented in an organized fashion is more meaningful and, therefore, more likely to be remembered than information that is not organized (Dembo, 1988). Students will also tend to adopt the organizational structure. Organization of information by a student requires active, voluntary processing of the information that helps insure that not only new information is more likely to be learned, but also aids in remembering information already stored in long term memory (Lindgren & Suter, 1980; Mayer, 1987).

Specific suggestions are: (a) Present new material in a clear and organized manner (Biehler & Snowman, 1986; Dembo, 1988). (b) Provide students with information regarding the structure of the material (i.e., tell the students how the information fits together). (c) Use outlines and behavioral objectives to make the purpose of the lesson very clear. (d) Tell students what you're going to discuss, discuss it, and then summarize or have them summarize what you've said. (e) Teach outlining, notetaking, mapping, and/or networking skills. In

networking, for example, students are taught to identify ideas and their relationships (Dansereau, 1978). Specific types of relationships among ideas are "part of, type of, leads to, analogous to, characteristic of, evidence for" (Mayer, 1987; p. 179). (f) Have students organize information on their own, according to their ability to do so.

Advance Organizers

The use of advance organizers, one specific method of supplying students with organization and structure, has been found to aid student learning by helping students structure and understand the incoming information. Specifically, an advance organizer (Ausubel, 1963) is information presented to the learner in advance of a body of new material that can be used by the learner to structure and understand the incoming information. The list of concepts provided in the first page of this manuscript and the headings are illustrations of advance organizers. Mayer's (1987) review of the literature indicates that advance organizers foster learning when (a) students lack prerequisite knowledge, (b) the goal of instruction is transfer of learning, and (c) concrete analogies are used. Although the lack of time may prevent teachers from using written advance organizers, the opportunity frequently exists for teachers to

use advance organizers in oral form prior to lecturing on new material (Klausmeier, 1985).

Memory Aids

Another method that helps students remember through organization is the use of memory aids such as linking, method of loci, peg-hook system, and the keyword method. They provide structures that enable learners to impose organization on unrelated bits of information. Mnemonics, an elaboration technique that provides a linkage between new material and language or images (Dembo, 1988), provide cues so that students can more easily initiate and carry through the processes of learning and remembering (Vander Zanden & Pace, 1984). Thus, mnemonic strategies help the student to organize information and have a positive effect on retention (Biehler & Snowman, 1986; Lindgren & Suter, 1980; Lefrancois, 1985).

Use of visual imagery as a memory aid significantly enhances the learning process (Higbee, 1977; 1979; Lindgren & Suter, 1980; Paivio, 1971; Vander Zanden, 1984; Yates, 1966). In fact, Paivio and Desrochers's (1981) research indicates that the most effective mnemonics use visual imagery.

Suggestions for classroom practice are: (a) Help students develop images or verbal cues for remembering important ideas.

(b) Have students devise and use mnemonic strategies on their own (Biehler & Snowman, 1986). (c) Provide students with general strategies such as acronyms or the keyword method and specific examples (e.g., Every Good Boy Does Fine).

Overlearning

Overlearning, learning information past the point of initial mastery, has been found to make the information easier to recall at a later time (Glover et al., 1983; Lindgren & Suter, 1980). Reviewing material that was presented previously has been found to enhance students' recall (Lindgren & Suter, 1980). Specific ways to teach students to overlearn material are: (a) Provide meaningful repetition of material rather than simply rote drill. (b) Give frequent, short tests. (c) Begin today's class by asking questions about yesterday's lesson. (d) Have daily and periodic reviews. (e) Have tests and assignments that require students to express what they've learned in their own words.

Automaticity

A concept closely related to overlearning is automaticity. Automaticity is a quality of cognitive processes that have become automatic over time and thus require little, if any, short term memory capacity (i.e., conscious thought) about the

mechanics involved. Cognitive processes such as reading, writing, spelling, and mathematics can become automatic with repetition (Glover et al., 1983; Mayer, 1987). Thus, meaningful repetition enhances the likelihood that cognitive processes will become automatic, freeing short term memory to focus on new material. Practical ideas are: (a) Provide students with meaningful practice opportunities for skills in which automaticity is desired. (b) Allow students for whom certain skills are not automatic extra time to complete tasks.

Individual Differences

Because there are important developmental differences in the acquisition of learning strategies, such as the ability to rehearse, organize, and use memory aids, teachers must remember that not all students process information or learn in the same way (Glover et al., 1983). Actions that educators can take are: (a) Present material through a variety of activities and media. (b) Permit students to set and achieve learning goals at different difficulty levels (i.e., not the exact same learning outcome for all). (c) Allow students to use different methods and materials to reach learning goals. (d) Vary the time that students spend to achieve the same goal (Klausmeier, 1985). (e) Teachers should try to lessen the gap in individual differences

between students by providing specific training in metacognitive and study skills (Dembo, 1988; Mayer, 1987).

Summary

A number of suggestions as to how teachers can incorporate more of the new knowledge gained from the information processing theory into their classrooms are provided in this article. In addition, the model provides a strong theoretical rationale supporting many traditional teaching techniques. If these applications of information processing theory are utilized, the outcome should be enhanced learning for our students.

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